From:	NSW Government
To:	Flood Inquiry
Subject:	Floods Inquiry
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Attachments:	On Higher Ground - a better future for Lismore.pdf

Your details

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Submission details

I am making this submission as	An academic/researcher
Submission type	I am making a personal submission
Consent to make submission public	I give my consent for this submission to be made public

Share your experience or tell your story

Your story	The attached report was completed in response to the flooding events in Lismore, by three co-authors. Two of them are academics resident in Lismore who experienced the flooding events in 2022 and have seen the impacts on local residents, businesses and the community. One has expertise in environmental management, the

	other in geography; the third author is an experienced planner.

Terms of Reference (optional)

The Inquiry welcomes submissions that address the particular matters identified in its Terms of Reference

1.1 Causes and contributing factors	The extreme flooding events of 2022 which inundated LIsmore were caused by extraordinary rainfall in the catchment area. Our report highlights the factors which cause flooding in Lismore.
1.2 Preparation and planning	The report demonstrates that there was inadequate monitoring of river heights in an important part of the catchment, which meant that accurate prediction of flood heights was not possible. Concomitantly, this meant emergency services were not provisioned with adequate and timely data as a basis for preparations to deal with the consequences of the disaster.
1.3 Response to floods	Emergency services were unprepared for the catastrophic nature of the events as a result of inadequate and inaccurate data provided to them. Additionally, the location of emergency services bases (SES, RFS and Police) in the Lismore LGA below flood height is extremely problematic, rendering the bases inoperable in major flooding events.
1.4 Transition from incident response to recovery	It is important for the recovery of Lismore for residents to have hope for a better future for their town. Urgent attention needs to be given to careful planning to rebuild parts of the town in new locales. There are possible sites for such relocation to occur. Rapid and detailed feasibility studies of the options need to be undertaken.
1.5 Recovery from floods	It is vital to protect residents and businesses in the Lismore community from the ravages of future flooding events. The authors of the report do not believe that engineered solutions will protect the community from future flooding events. Relocation of parts of the town will be the

	only long term solution for the town. Our Report argues that this is economically feasible compared to the cost to residents and the state and nation of repeated recovery and rebuilding after major floods. The likelihood of increased intensity and frequency of flooding events associated with climate change adds urgency to the need to relocate parts of Lismore.
1.6 Any other matters	Our Report, On Higher Ground: A better future for Lismore, is attached.

Supporting documents or images

Attach files	• On Higher Ground - a better future for Lismore.pdf

On Higher Ground

– a better future for Lismore

Barbara Rugendyke

Jerry Vanclay

Angus Witherby

Overview

Lismore is a shattered town. On 28 February, 2022, the rapacious Wilsons River robbed residents on low lying areas of their possessions, their homes, and left them fearful for their future safety. Tragically, some people were swept to their death. Devastated by two floods within a month, not a business in Lismore's CBD was spared the ravages of the floodwaters. Collectively, the community of Lismore and its hinterland mourn the loss of life, livelihoods, homes and of their town. For them all, life has changed immeasurably.

This purpose of this report is to present the case for rebuilding a new Lismore CBD, on higher ground. It argues that, for Lismore to prosper into the future, it is essential that it build a new heart. The reasoned evidence for this case is presented in this document. In brief, our argument is:

- careful study of the catchment, and of the monitoring of rainfall and river heights during flood events, illustrates that flood mitigation measures cannot protect the town from inevitable future flooding;
- there is a strong economic argument for relocation of parts or all of Lismore's CBD; indeed, relocation will be more cost effective over the longer term for all stakeholders;
- the negative social, emotional and psychological impacts of devastating floods also provide a strong rationale for relocation of businesses, services and flood affected housing to higher ground;
- there are possible appropriate sites for planned, staged relocation; these include public land, located above the highest recorded flood height and geographically suited to redevelopment of the town CBD;
- if you can't remove the risk, move people from the risk - this is apt and viable for Lismore.

Our hope is to stimulate discussion as a contribution to planning a better future for Lismore, to build a town with a new, protected heart.

Adjunct Professor Barbara Rugendyke, Geographer
Professor Jerry Vanclay, Environmental Scientist
Mr Angus Witherby, Planner and Economist

14 April, 2022

On Higher Ground: *a better future for Lismore*

It now six weeks since record-breaking catastrophic floods in Lismore. There has been some discussion about engineered solutions or relocation to protect the town, its residents and businesses from the ravages of future floods. Without a decision about this, flood victims are left wondering if they should make temporary or permanent repairs. The community needs an open discussion about the options, a resolution to give the community confidence that the best decision has been made and that it can move forward with a common purpose.

We write as a group of professional people, two of whom live in or near Lismore, who decided to use their expertise to explore options in more detail than we have seen to date in the media or elsewhere. This report examines some of the issues, demonstrates the cost of choosing to relocate or not, and urges for detailed feasibility studies as a basis for decision-making. One of us has expertise in environmental management, another in geography, community development and social impacts of change and the third in planning, geography and economics.

Is flood mitigation an option?

Existing flood mitigation measures

Let's begin by looking at the current situation and some alternatives. The existing levee was constructed in 2005, served the CBD well for 12 years before overtopping in 2017, but failed twice early in 2022.

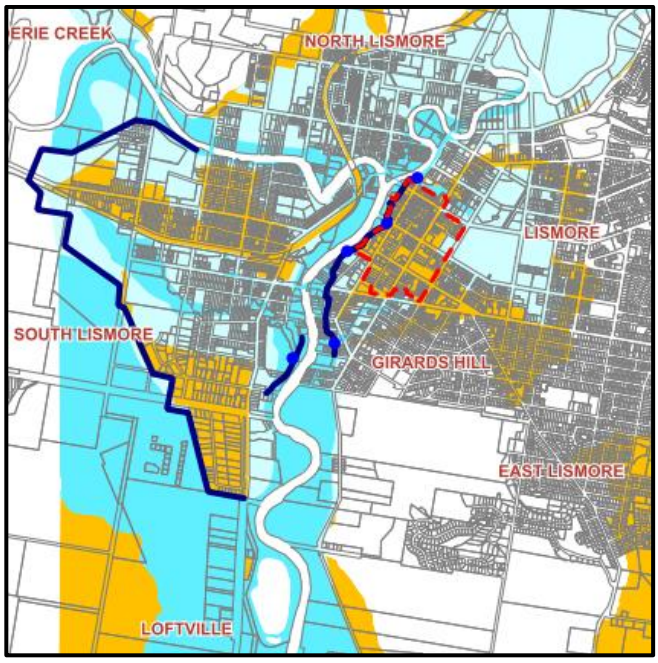

Figure 1. The Lismore CBD (red dashes) is protected by a levee (dark blue line) and pumps (blue dots) along the east bank of Wilsons River. A second longer levee protects South Lismore. Floodways are shown in dark blue, vulnerable areas shown in pale blue, and areas considered 'low-risk' are shown in orange (Lismore GIS[1]).

[1] https://mapping.lismore.nsw.gov.au/intramaps99/default.htm?project=LismorePublic

Additional engineering works were constructed following the 2017 flood[2]. The plan was to modify an existing floodway to the west of South Lismore to divert water around the town, with the modest goal of reducing the peak of a major flood (of 12.38m, the 1% Annual Exceedance Probability AEP) by just 0.1m. This goal of 0.1m was not ambitious - it represents the width of one's palm, slightly more than one course of bricks, and slightly less than a typical weatherboard. Such modest reduction would not have made a material difference to most householders, even if it was achieved – and there is little evidence of any reduction during the recent floods (Figure 2).

These most recent engineering works rely in part on a LIDAR-based digital elevation model[3] that reflects an impressive amount of detail – but the geographic extent is rather limited, as it does not include Tuncester to the west (4.5km west of the Wilson-Leycester Creek junction), Woodlawn (3.2km) to the north, nor Sandy Point (4.8km) to the south. Was this really sufficient geographic extent to make useful inferences about the impact of major floods in Lismore? It would also seem desirable to acquire LIDAR imagery of the river during a flood event, so that a thorough analysis of flows and impediments could be undertaken.

Figure 2. Photos from Rotorwing Helicopter Services[4] showing two images of these engineering works: (**left**, 10am 31-3-22) looking northwest across the completed improvement (top centre), with the sewerage works top left, Leycester Creek top right, and zig-zag drain bottom left; (**right** 30-3-22) looking south across the partially-flooded airport towards the Bruxner Highway, showing the zig-zag drain filled to capacity with nowhere to flow.

Clearly, it is rather difficult to correctly predict future scenarios and to engineer viable solutions. So, a good place to begin is with a careful assessment of the data available to support inferences about flooding and possible solutions.

[2] https://www.dailytelegraph.com.au/news/nsw/lismore/8-million-flood-plan-could-drive-investment-in-cbd/news-story/0073832f63040ab4a9156aca7573697d

[3] Worley-Parsons (2016) Lismore Flood Model - LiDAR Update, Final Report https://yoursay.lismore.nsw.gov.au/46886/documents/107853

[4] https://www.facebook.com/rotorwinghelicopters

Rainfall and stream monitoring in the Wilsons River catchment

Let's begin with a quick look at the Wilsons River catchment. This image is compiled from the Lismore GIS[6] so is trimmed at the Local Government Area (LGA) boundary in the east and omits the upper portion of the Wilson River, and all of Byron and Pearces Creeks, but it gives a good overview of the eight major sub-catchments that contribute to Lismore's floods.

Lismore is at the confluence of a number of major streams. The Bureau of Meteorology (BOM) reports stream heights for the Back, Leycester, Goolmangar, Coopers and Wilsons tributaries (with multiple sites on some streams), but offers no reliable insights on Terania Creek (nor on Numulgi or Byron[5] Creeks – however, the Woodlawn site for Wilsons River is below the junction so is inclusive of both Numulgi and Bryon Creeks). WaterNSW[6] reports stream heights and flows for Leycester, Goolmangar, Coopers, and Wilsons tributaries (shown as red circles in the figure above), but offers no insights for Back, Terania or Numulgai Creeks. Terania Creek in particular, is not monitored by either the BOM or WaterNSW, despite including Rocky Creek, the site for the proposed Dunoon Dam[7].

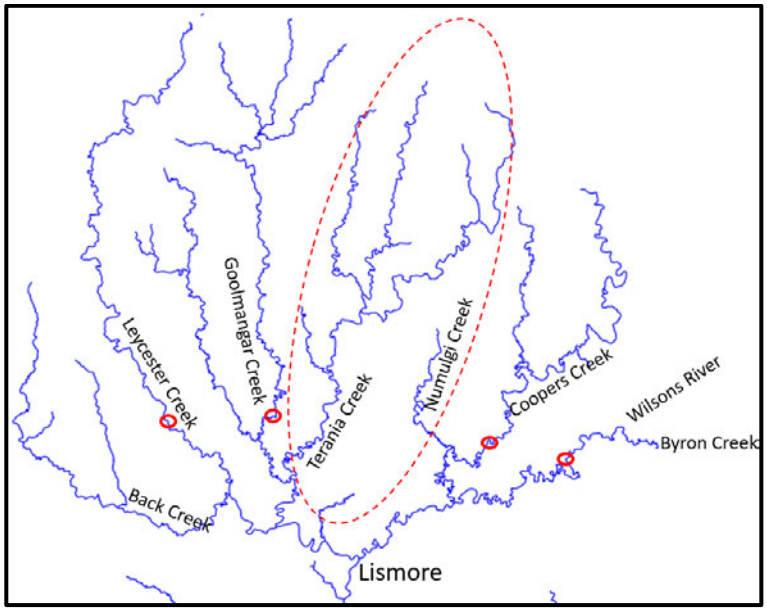

Figure 3. Catchment for the Wilsons River and Leycester Creek junction at Lismore.

Dunoon, which sits on a ridge between Rocky and Numulgi Creeks, recently recorded the 2nd highest overnight rainfall in NSW[8], 775mm in 24 hours to 28 February, and this water would have drained into Numulgi and Terania Creeks, but neither of these creeks is monitored to record the resulting runoff or its impact on the record Lismore floods in the following days. Terania and Numulgi Creeks are not insignificant, collectively draining about 20% of the Wilsons catchment (shown as a dashed red oval) above Lismore – why do these streams remain unmonitored in NSW's most flood-prone catchment,

[5] To clarify – Byron Creek starts 3km from the sea just south of Byron, flows inland to join the Wilsons, then returns to the sea via Lismore and Ballina…
[6] https://realtimedata.waternsw.com.au/
[7] Tenders were called in 2020 to estimate the acquisition costs of land for this dam (https://www.australiantenders.com.au/tenders/415242/dunoon-dam-future-water-strategy-land-acquisition-costs/), but the proposal has since been suspended.
[8] https://www.weatherzone.com.au/news/second-heaviest-daily-rainfall-ever-observed-in-nsw/536322

where a $220 million dam[9] has been proposed, and where there is a long history of investigating and constructing flood mitigation devices?

The Bureau of Meteorology's website is a convenient and oft-used resource for checking recent rainfall and flood conditions – and has about 20 sites for rainfall, and about 20 for stream monitoring in the Richmond basin.

BOM records are handy for a quick look at rainfall, but can be misleading for stream monitoring, because different gauges have different reference marks – some use Australian Height Datum (AHD, corresponding to mean sea level at Ballina), some use Richmond Valley Datum (the low water of an ordinary spring tide, somewhere between 0.81 and 0.86 below than AHD, depending on the site), and others use an Assumed Datum (so indicates the depth of water above the bottom of the stream)[10]. If you want to drive your vehicle across a ford, you want to know the depth over the ford (hence the assumed datum), but if you want to compare an upstream with a downstream reading, you need to know the datum used for each, preferably the AHD. Unfortunately, the BOM website doesn't always reveal which datum is used, or how to convert from one datum to another. But these data can still offer interesting insights.

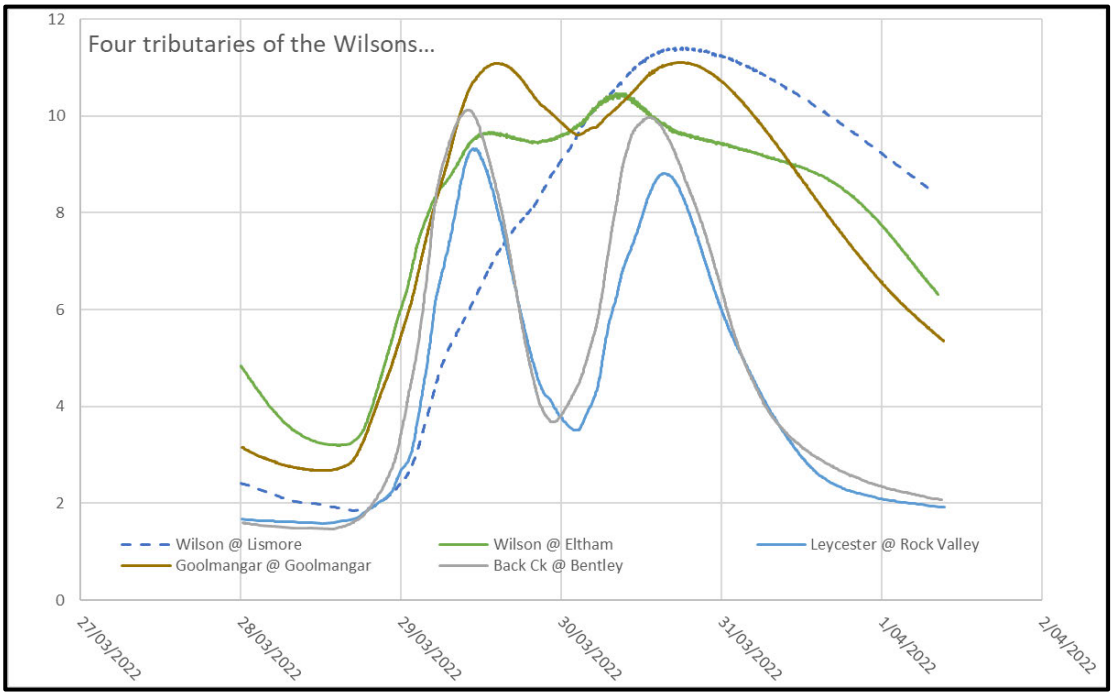

Figure 4. Flood heights in metres for tributaries of the Wilsons River, 29 and 30 March, 2022.

This graph shows four of the major tributaries of the Wilson above the Wilson-Leycester Creek junction (near the town centre, at Union, Woodlark & Bridge Streets). In the western part of the catchment, Back and Leycester Creeks exhibit two distinct peaks, one on 29th and another on 30th March, 2022. Further east, the peaks in Goolmangar Creek are a little higher and conjoined. Still further east at Eltham on

[9] https://rous.nsw.gov.au/cp_themes/widgets/faq_001.asp?b=20#f20-2
[10] Richmond River Flood Warning and Evacuation Management Review. R.B20357.004.01 Final Report, 2016 https://rous.nsw.gov.au/page.asp?f=RES-FWT-11-04-76

Wilsons River, peaks from the two rainfall events have merged. Below their junction where they form the Wilsons River in Lismore, these peaks blur into a single peak.

These five lines tend to fluctuate independently, but during 30 March, the Goolmangar and Wilson@Lismore curves are parallel, in lock step. Is this because the eastern tributaries delivered so much water that water is backing up into the Goolmangar; because the Goolmangar carried the major flow on this day; or because the unmonitored Terania Creek flow dominated both the Goolmangar and Wilson@Lismore heights? It is impossible to shed light on these questions, in part because it is not clear which datum each gauge utilizes, because only heights and no flows are recorded and because Terania Creek remains unmonitored.

However, these height data from the BOM also have a hidden danger as a small change in stream height can mean a large change in water volume. For instance, the calibration curve for the WaterNSW Eltham site (Wilsons River) shows that for an increase in water height from 9 to 10m, water volume increases from 20,000 to 50,000 Megalitres/day – a 10% increase in height means a 2.5-fold increase in volume. Obviously, this depends on the topography at each monitoring site, but the relative increase in water volume is always greater than the relative increase in height, often much greater. So, the convenient BOM stream height data do carry some danger of complacency.

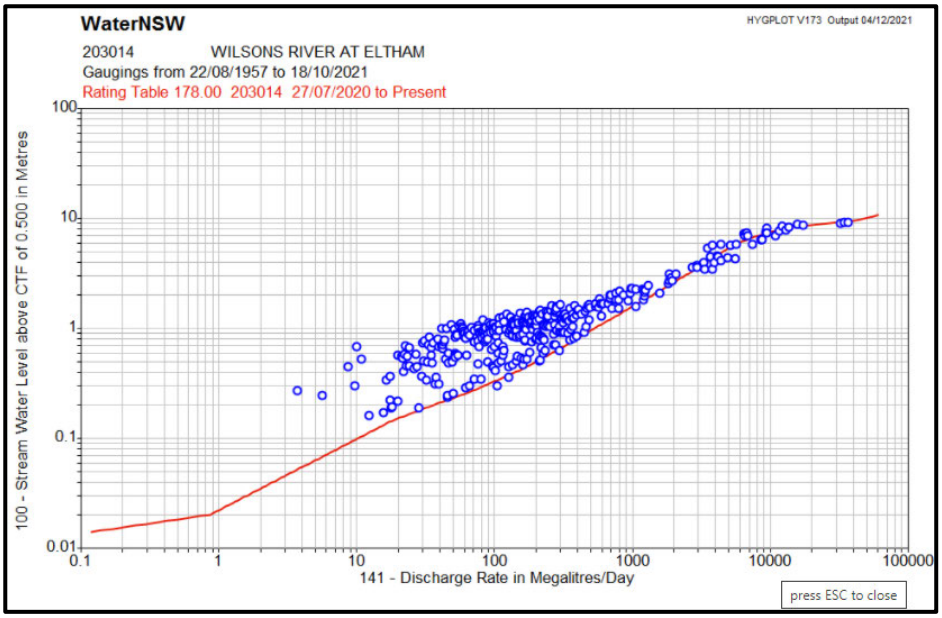

Figure 5. WaterNSW Wilson River at Eltham historic data.

WaterNSW[6] offers another source of data, that includes levels (i.e., heights) and discharges (i.e., rates of water flow; some sites also include rainfall, water quality and other attributes), and also facilitates access to historic data. It is instructive to compare the stream heights and flows during the record-breaking flood of February 2022, and note how stream heights convey quite a different impression than do stream flows.

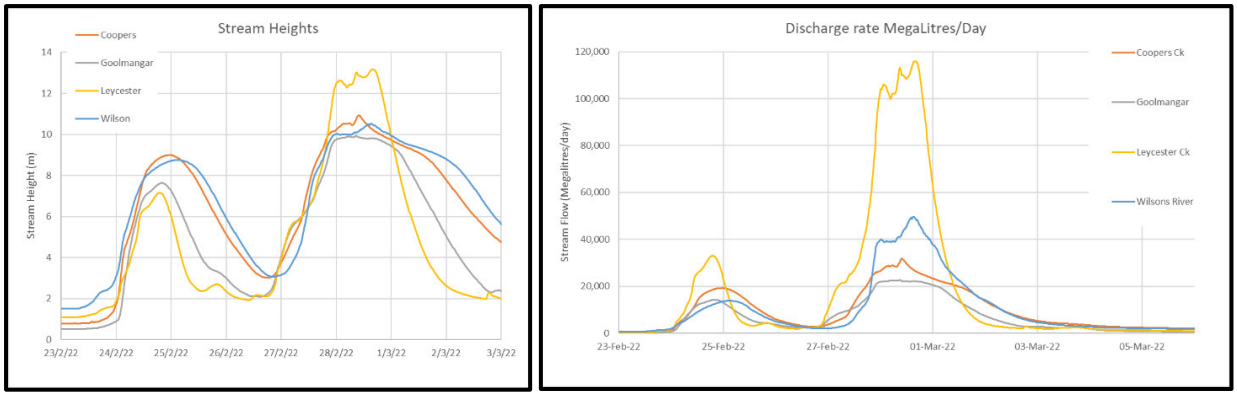

Figure 6. Stream heights and flow, Wilson River catchment, February 2022.

The cumulative flows for the 7-day period (from midday 26 Feb) reach 400 and 260 gigalitres – to put this into context, it represents 70% (February flood) of the volume of Sydney Harbour passing through these 4 stream gauges, and ignores any contribution from the Terania, Numulgi and Back Creek catchments. It is as if the entire contents of Sydney Harbour had been dropped on the southern slopes of the Nightcap range during the night of 27-28 February (given the record-breaking rainfall in Dunoon is seems reasonable to assume that Terania Creek likely contributed a substantial volume, bringing the total to a 'Sydney Harbour' or more).

It is also worth comparing various flood events, and observing that every flood is different.

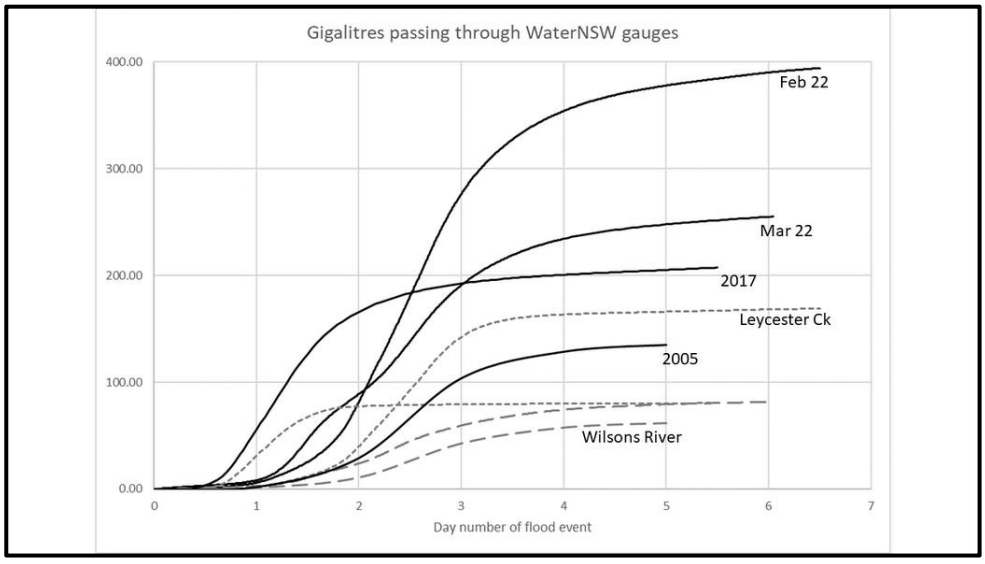

Figure 7. Every flood is different – Major floods of the Wilsons River, Water NSW.

This figure summarized four floods since the $19m levee was constructed, showing both the total recorded stream flow, and the tributary with the largest recorded contribution. The 2005 flood threatened to overtop the levee even before it was officially opened[11] (but fortunately climaxed just below the top of the levee). The 2017 was the first flood to overtop the levee, and the two 2022 floods need no further comment. In 2017 and Feb 2022, Leycester Creek had the largest contribution of the

[11] https://www.abc.net.au/news/2005-06-30/lismore-residents-evacuated-ahead-of-flood-peak/2048020

four monitored tributaries. In 2005 and March 2022, Wilsons River had the largest contribution (but Goolmangar Creek was not monitored in 2005). And the total flow remains undocumented, as Terania Creek has never been monitored, and it may be – as in any sleight-of-hand magician's act – that the crucial action happens where no-one is watching.

But what about downstream?

In images above, it is notable that the Wilsons at Lismore quickly approaches the heights observed in the four tributaries, and it is worthwhile to look downstream and observe how the flood peak travels below Lismore. Downstream, the floodplain is wide and flat, so the dynamics are very different, but despite this room for the river, the flood peak at Lismore dissipates gradually downstream.

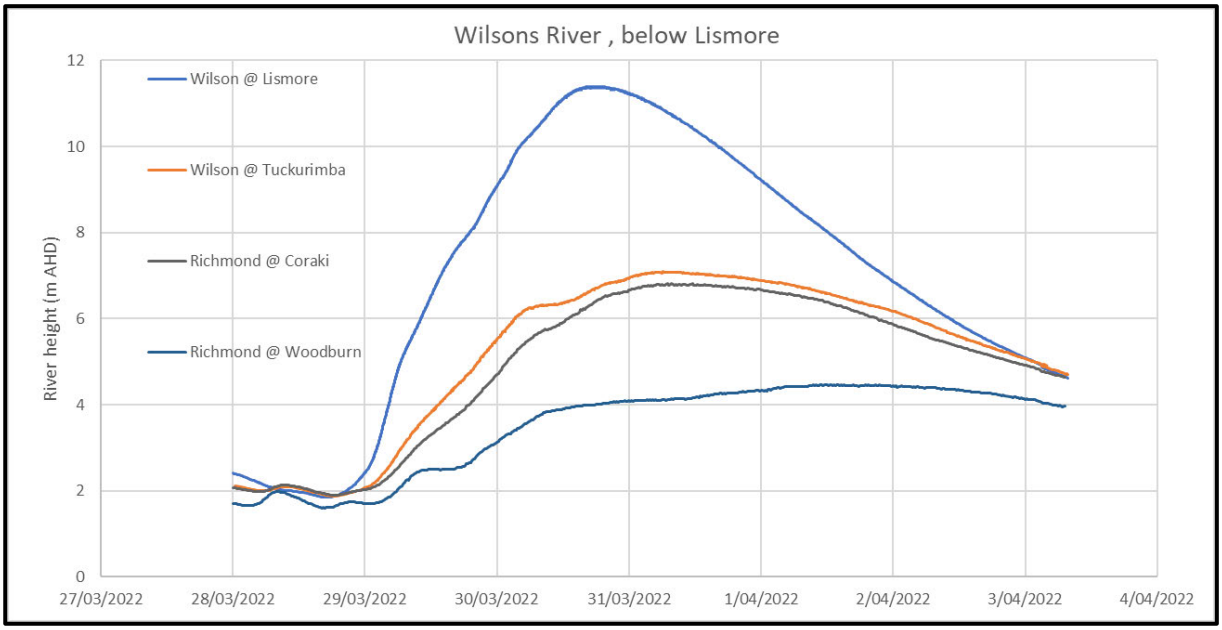

Figure 8. Flooding of the Wilsons River below Lismore, 2022.

So far, we have looked at how a flood unfolds over time at a given site. It is also interesting to consider how a flood appears at a given time across a linear transect along the river. This graph (below) shows river heights at five sites down the Wilsons River, from Woodlawn (near the head of navigation), during the March 2022 flood. The topmost solid line shows the river gradient at the top of the flood peak at Woodlawn; dashed lines show the trend as the river rises, and dotted lines record the falling river.

The dashed line at the bottom shows the state of the river at the first indication of a flood, showing that (as expected for a liquid) water finds its own level and is almost horizontal across the whole river basin. The lines get steeper and steeper as the river rises, and then gradually level out as the river falls. However, it is notable that the gradient between Lismore and Tuckurimba is always the steepest, implying that there are some 'choke points' hampering the natural flow of the river.

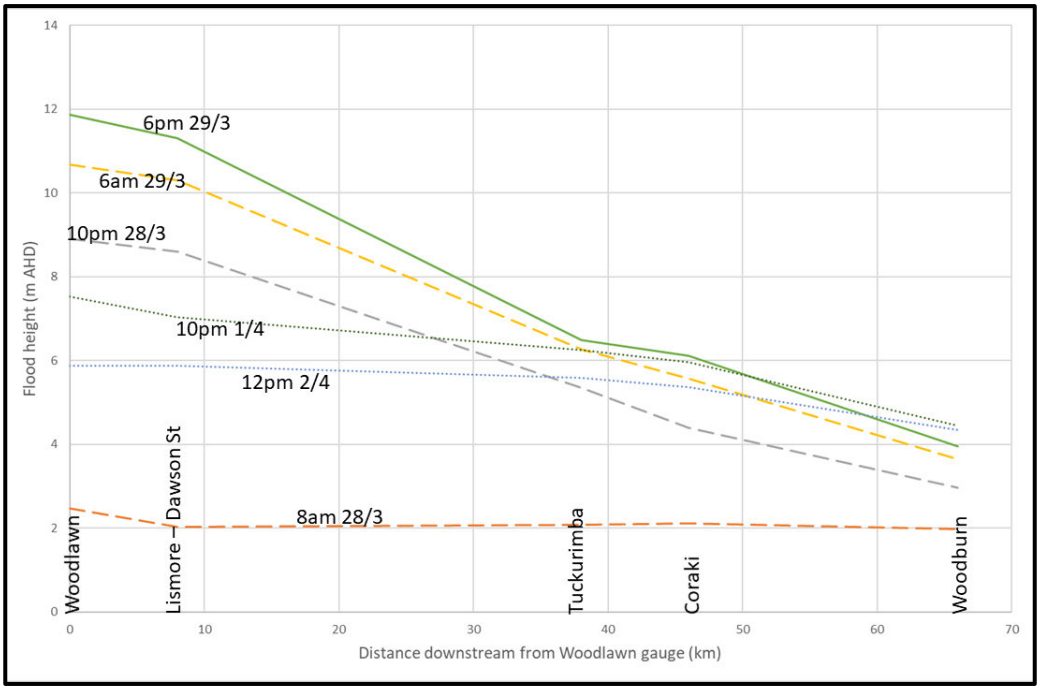

Figure 9. Falling flood heights downstream, Wilsons River.

For the most part, the floodplain below Lismore is wide and flat, allowing room for floods to disperse, however, some potential choke points are evident in the image below (left, from Lismore GIS, with 10m contours). The floodplain south of Bunnings has several structures above 10m that would impede floodwaters – a natural levee on the east bank opposite the recent 'Masters' excavation (below, top centre of middle image); the Bruxner Highway embankment; and several mounds in the vicinity of Sandy Point Road.

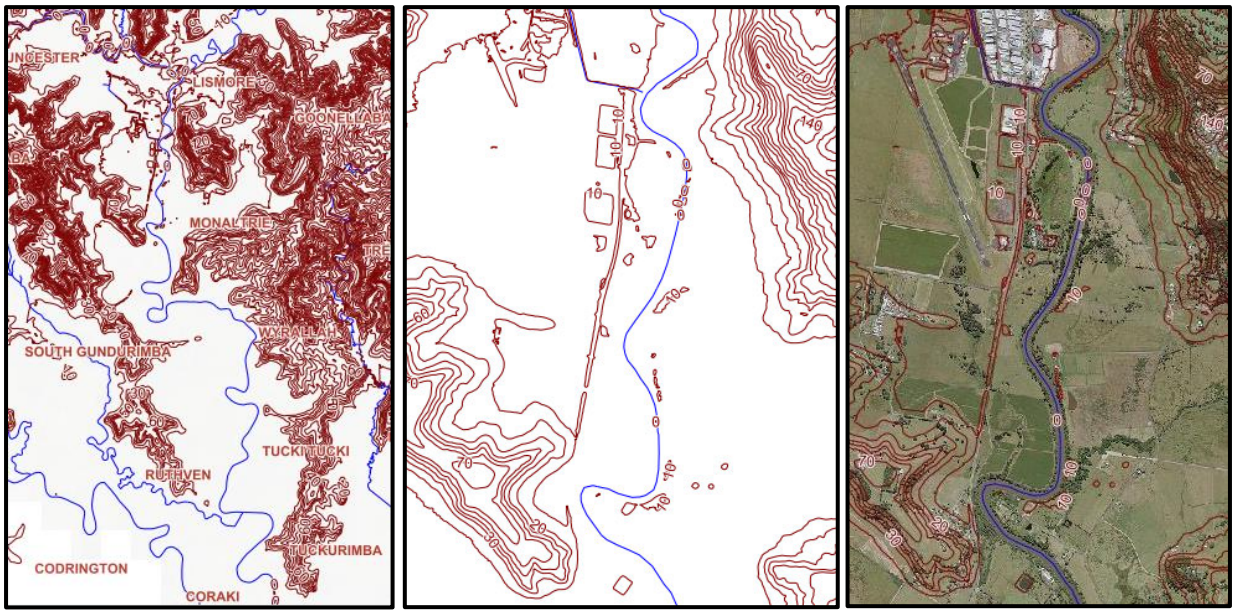

Figure 10. The floodplain below Lismore

In particular, the river channel just below Bunnings is only 155m wide at 10m elevation, despite the recent 'Masters' earthworks and the $8.2m investment in the zig-zag canal (just south of this point; bottom left of left image below). Further south, at Sandy Point, the channel is 1300m wide at 10m elevation but is obstructed by numerous mounds higher than 10m. These restrictions are likely to contribute to the slow drainage of floodwater from Lismore.

Figure 11. Drainage of flood waters from Lismore is impeded by mounds.

So, what are the options for flood mitigation?

Firstly, we need better data. There are no publicly-available calibrations of discharge rates at the Lismore (Dawson Street) gauge, so the true volume of water involved in Lismore floods remains unknown, and estimates derived from summing flows in four of the tributaries remain an underestimate, possibly a large underestimate. No LIDAR data of the water surface has been collected during a flood peak to offer closer insights into river flow and the river gradient to assist future planning.

Secondly, we should observe that 'hard' infrastructure (canals, levee embankments) are expensive, depend strongly on data quality (small biases in data and assumptions can have major consequences), and are prone to sudden failure (e.g., when a levee overtops). In contrast, soft interventions (that facilitate or calm river flow across floodplains) can operate at any scale, and do not have sudden points of failure. So hard infrastructure would appear to be a poor investment at this time of poor data and changing flood patterns.

There is evidence that floodwater drains more slowly below Lismore, in the Lismore-Tuckurimba section of the river, than in other parts of the catchment, so it seems desirable to remove buildings, artificial mounds and other impediments to water flow in this section of the river, and to maintain these floodplains as pasture and low crops. Conversely, floodplain management upstream of Lismore could include incentives to slow and calm approaching floodwaters to encourage a slower, shallower flood - by restoring wetlands, reducing soil compaction (excluding cloven-hoofed stock when waterlogged), and regenerating floodplain forests (like the Boatharbour and Booyong Nature Reserves), establishing koala habitat, and encouraging horticulture (such as the pecan orchards near Boatharbour). However, the nature of the Wilsons catchment above Lismore is such that flood mitigation efforts will yield relatively small changes in flood peaks.

The most important measure is the relocation of vulnerable businesses and housing out of the floodplain. In the past 150 years, Lismore has had 18 floods[12] that have exceeded the levee height - and

[12] https://lismore.nsw.gov.au/files/Lismore_Flood_Events_1870-2017.pdf

we should expect flooding to get worse. Climate change means downpours that are more frequent and more intense[13]. And changes in our catchment continue to increase runoff – grazing leads to soil compaction and more runoff; horticulture often involves plastic sheeting that increases runoff; urban development includes hard surface that increase runoff volume and speed. The result is more flooding, and more intense flood events, so the only solution is to relocate key infrastructure away from the floodplain.

The Economics of Relocation

In determining the viability of relocation of parts of the CBD of Lismore, together with the most vulnerable housing, it is essential to consider the costs and benefits in economic terms. The key question which needs to be answered is: does it make economic sense to consider a new CBD, at least in part, together with supporting housing?

Solid numbers around financial costs of floods are difficult to come by. Every press release of the Insurance Council of Australia places a higher price-tag on the SE Queensland and NSW flood events of February to March, 2022. From $900M[14] to $1.3B[15] to $5B[16], the amount keeps climbing. It is possible though to develop some initial 'broad brush' numbers to see if the economics of a new CBD and supporting residential areas are worth serious investigation.

Rebuilding the CBD

Some starting assumptions are essential. While the overall CBD and periphery covers some 60 hectares, the core of the CBD is closer to 20 hectares. There are, based on a recent retail census conducted for the purposes of this paper, some 330 businesses in the core CBD, ignoring those located in the arcades and upper floor commercial buildings. It is possible to estimate stock losses, equipment losses and clean-up/repair costs. With the addition of waste disposal and public realm costs, a preliminary estimate to get the businesses located in the core CBD back on their feet is $440M. This does not take into account lost wages during the flood event for proprietors or their employees, but does include losses in turnover. If we assume another (say) 5 floods over the next 20 years, total costs would be in the order of $2.2B. These $2.2B are avoided future costs, if the CBD is located somewhere else. On this number alone, the potential cost savings over time resulting from relocation of the CBD are massive.

[13] https://www.climatecouncil.org.au/resources/climate-change-floods/#:~:text=Climate%20change%20is%20affecting%20our,a%20greater%20risk%20of%20floods.
[14] https://www.artemis.bm/news/ica-gives-900m-early-australia-flood-insured-loss-estimate-says-will-rise/
[15] Wood, Daniel, 2022 *Floods Update – 86,000 claims and rising.* Insurance Business Australia
[16] https://www.news.com.au/finance/economy/damage-bill-for-floods-in-nsw-and-queensland-expected-to-top-5-billion-as-questions-are-raised-about-who-should-pay/news-story/ea69a7804ee53e764635b8ff3e37e11c

Figure 12. Businesses in Lismore's CBD, devastated by flooding, including loss of stock, equipment, fittings and major structural damage. Photos: Barbara Rugendyke

Residential

Damage to dwellings is still being assessed and this will take months. It is possible, though, to make some preliminary estimates. Potentially some 5000 dwellings have some form of damage, of which maybe 1000 have severe damage and 50 may need to be replaced altogether[17]. The Insurance Council of Australia has estimated total costs and the number of claims. Although both are rising, the average cost per dwelling is around the $22,000 mark[18]. If we look at a typical cost to replace a modest house, and make an assumption about major repair costs, we can come up with some estimates. Spreadsheets being what they are, these numbers can be refined as better data becomes available. An initial estimate of residential rebuild costs though is approximately $600M[19].

[17] These are very preliminary estimates based on a variety of media reports. See for example After the flood: Lismore's future in doubt with 4000 homes uninhabitable (smh.com.au) and Almost 5000 homes deemed uninhabitable after NSW and Qld floods (afr.com)

[18] Estimate based on ICA estimates of total claims and total losses from a variety of media sources

[19] See appendix for spreadsheet summary

Figure 13. Dwellings sustained structural damage. Photo: Barbara Rugendyke.

So, altogether, at a very general level, the cost is likely to be over $1B to rebuild Lismore's CBD and dwellings in their current location.

Costs of a new site

Let's look at the other side of the coin, what the costs might be to develop a 20ha new CBD plus residential housing on, say, a 60ha site. Estimation of development costs is complicated, depending very much on what is already there, the topography, and a range of other factors. There is a fairly well-developed literature on development costs, from which a range of estimates can be derived. In rough terms 'roads, pipes and wires' infrastructure are likely to be in the order of $65,000 per lot[20], and each hectare of land can contain about 22 lots at around 650m^2 per lot.

The assumption has been made here that infrastructure costs will be roughly equal per hectare for commercial and residential development. Road costs will be similar, as will water supply, which is largely driven by fire-fighting needs. Sewer is likely to be roughly equivalent and power probably higher. Under these assumptions a 60ha site would therefore require an expenditure of about $85M for the basic infrastructure. On top of the costs within the site, there is necessary upgrading of infrastructure outside the site, in support of the site. Without existing services information being available, a 25% loading has been applied, giving us $106M. We can round this to, say, $110M.

These funds could come from grants, or they could come from loans, to be paid back over 30 years or so through (for example) a special rate. Given the alternative costs likely to be incurred by any efforts to construct physical mitigation (noting the limits on what can be done outlined elsewhere in this report) these costs are not large, and would be a prudent investment by Government to save costs associated with future flooding.

If the land is in the public realm, and Government wants to facilitate a CBD move, then it is possible to avoid some significant development costs. In particular, the land could be made available at minimal

[20] See spreadsheet summary in appendix

cost – which, while this is a real cost, it is one that does not need to be paid up-front. In addition, the public realm could forego the costs

There are additional costs associated with the construction of buildings. When it comes to having to replace buildings altogether, this is a 'neutral' cost, as it would be roughly the same on a new site as for an existing site. It would certainly be more expensive to rebuild rather than repair in many instances, and this needs to be considered.

Indications are that current building costs may, on average, be some 30% or more than they otherwise typically might, due to demands on the sector, together with the rapid escalation of materials costs and ongoing supply chain disruptions. [21]

To build again on a new site or sites, a preliminary estimate is that this would cost in the order of $400M for the CBD component, and an estimated $440M[22] for the residential components. Round this up and include land development costs and a likely total would be about $1B.

So, in very rough terms, the cost of go or stay would be about $1B. There is significant repair work needed to the CBD public realm in Lismore, including roads and Council owned buildings, which can be compared against the potential costs of new infrastructure elsewhere.

When, however, the avoided costs are considered, the sum of the residential and commercial costs of anticipated flooding over the next 20 years could be over $4B. On this basis, relocation of the CBD and the housing most severely impacted by flooding is the best course of action for the future based on economic grounds, even if the costs outlined here are, as a rough estimate, subject to considerable refinement.

Avoided costs over time will be considerably higher than is estimated above if other costs associated with loss of businesses and homes are factored in. For example, loss of employment leads to higher demand for income support from public funds. The emergency service response for each flood event, prolonged provisioning of evacuation centers and for people dislocated from homes, and supply of accommodation and sustenance for service personnel and others assisting in relief and recovery efforts all come at considerable cost. Our estimates therefore as to avoided future costs are conservative indeed. Relocation of businesses and housing will result in further enormous savings for the public purse by reducing the wider negative impacts of repeated future flooding events.

Relocation is not just about economics …

Based on the evidence presented here earlier, the reality is, future flooding events in Lismore will be unavoidable and it is difficult to accurately predict future flood heights. Additionally, the economic arguments for relocation are very strong. This is before the emotional and psychological toll of flood events, which also have significant negative social impacts, are considered

Those whose homes were inundated have lost many or all of their possessions. Many narrowly escaped with their lives. Some were less fortunate; their family and friends are left to grieve their loss. The personal impact of the floods on those directly affected is enormous. The economic losses incurred by businesses following each flood also have flow on social effects.

[21] https://www.9news.com.au/national/home-renovation-costs-soar-material-supply-chain-in-crisis/29437b26-37d8-4939-a631-b8c80fbe3292

[22] See spreadsheet summary in appendix.

Figure 14. Residents impacted by flooding of Wilsons River lost all of their possessions in February 2022. Photos: Barbara Rugendyke

The personal and social impacts of the flood are outlined below. These observations are based on action research, comments gleaned while cleaning out alongside flood affected friends and community members and informal conversations across the community.

Unemployment

Loss of employment is immediate after flooding events. Businesses are closed for extended periods of time, resulting in loss of income for their owners. Additionally, business owners are unable to continue to employ staff immediately after the flood, and often for extended periods of time, until they are able to operate again and recover some of their losses. At the time of writing, power has not yet been restored to the CBD in Lismore, rendering businesses inoperable from the time of the first flood on 28 February until, at this stage, a predicted restoration of power just before the Easter weekend commencing 15 April, 2022. Thus, there will be a nearly two-month time frame between the first flood and power being available to businesses. Then, there will be the extended time frame associated with renovation and repair of flood damaged business premises, if building trades and materials are even available. Some business owners advise it is likely to be six months before they are able to commence operations again. This may be optimistic.

This loss of employment does not only relate to commercial and retail businesses. Schools, nursing homes and other education, social and care services have also been impacted by flooding and staff have lost employment as a result. Some have been advised that their former position is unlikely to be available for at least six months until the care facility, service organisation or other operations can undertake necessary building repair and renovations and source necessary replacement equipment.

Loss of business diversity and skills

People left without employment as a result of flooding can be forced to relocate to find work. This can result in permanent loss of skills to the town and region. When people commence new jobs in a new location, especially in the face of the loss of a CBD and the expected long-term impact that has on daily living, and even more so if their home had been inundated, they may not return to the town at all. Thus, their skills and experience are lost to the region, and there is a risk of population decline.

Many people who have lost their homes report leaving their employment. Some are without electricity and still repairing and cleaning their homes six weeks after the flood. Some are in temporary accommodation, or in caravans in their driveway. Given the trauma they have experienced, loss of clothing and possessions and their inability to 'do normal life', such as have a shower and cook food in their homes, attending work each day is simply too hard for some. As is often recounted by people who are rough sleeping, it is too difficult to sustain employment from a position of homelessness. People thus impacted by the floods are anxious about whether their position will still be available when their circumstances allow them to return to work.

Many business owners known to the authors have said this is 'one flood too many' and plan not to reopen. This can result in loss of business diversity in the town. Others plan to commence trading in their flood prone location after restoration of their premises, particularly if they own their building, as a matter of economic necessity to try to recover losses. However, a number report that, if there was an alternative site available to them which is above flood height, and with appropriate compensation offered for their existing site and building, they would gladly relocate.

Loss of amenity and CBD functions

Currently, Lismore's CBD resembles and is being referred to widely as a 'ghost town'. While some refer to the need to rebuild 'better' and to try to 'flood proof' their businesses, the reality is, many business owners feel unable to face repeated flood events. Real estate agents report residential and commercial tenants 'throwing their keys in the door', stating that they will not be back. Following major floods, the damage to buildings, both residential and commercial, and the empty shops give the town a tired, run-down feel. The considerable loss of amenity means that tourists, visitors and local people are less likely to want to visit the town for recreational activity.

Town residents are forced to drive long distances to access basic services and specialty retail stores while the town is rebuilding. This involves a 10 km return trip from Lismore's current CBD to the high ground supermarkets in the suburb of Goonellabah, 35 km round trip to Alstonville, 64 km round trip to Ballina or 92 km round trip to Byron Bay. This situation is likely to exist for an extended period of time. This is costly in terms of time, inconvenience and increased travel costs and is proving frustrating for residents.

The necessity that Lismore residents travel to other towns nearby places pressure on the businesses in those towns; businesses in those towns don't necessarily have the capacity to meet the needs of the population from Lismore and its surrounding villages and hinterland. Individuals have reported car park rage, crowding, stresses, inadequate supply in the few functional supermarkets, speciality food and other stores in those parts of Lismore which were not impacted by inundation. This is stressful for local community members, and for the staff of the businesses trying to meet the needs of a population far larger than those they usually cater for. Town residents may form new shopping habits and won't necessarily move back to shop in Lismore's CBD when businesses reopen there, particularly if many businesses don't return and it is easier to travel to one site for residents to complete activities there. There is a real possibility that Lismore may become a town without a functional CBD – a sea of suburbs adrift from its centre.

Emotional and psychological toll

The psychological trauma and mental anguish resulting from the flooding is widespread. Those immediately impacted by the floods, forced to flee their homes in the middle of the night, many

narrowly escaping with their lives and losing all of their possessions, are traumatised, shocked, and devastated, facing an uncertain future. Many lost businesses and livelihoods as well their homes.

Many of those displaced from their homes, at the time of writing, seven weeks after the first flood, are still camping with friends or relatives, or in temporary accommodation after extended periods in evacuation centres. They suffer loss of privacy, loss of a sense of home, and are sharing facilities with people outside their immediate family. People not directly impacted by inundation report feel shattered and depressed at the impacts of the flood on friends and family members.

Those hosting people left homeless are in turn experiencing crowding in their homes. Some are bearing the cost of financially supporting additional people in their households, with increased expenses for utilities and sustenance, along with increased workload associated with additional people residing in their home. This places stress on households and relationships.

The floods of 2022 have placed an enormous emotional and psychological toll on the entire community. For all Lismore residents, the shock at the loss of their town centre is very real. It is dispiriting and depressing for all town residents to have no town centre to go to. All residents of Lismore are impacted by the loss of the retail precinct, of restaurants, cafes, services, professional offices, entertainment venues, cultural facilities. The places they would usually visit for recreation or social activity, the cafes and restaurants they enjoyed visiting, are simply not there and may not be for many months. The entire community shares grief at the loss of the town and the opportunities it afforded them.

Importantly, the loss of the CBD results in loss of a sense of community as Lismore people disperse to seek services, retail outlets and entertainment beyond the town. Despite a strong sense of community and willingness to support local businesses, after the catastrophic flooding event in 2022, people feel uncertain about its viability and safety in the future.

People across the town refer to flood fatigue and the wish for some ‘life as normal’. Despite strong, inspirational community spirit in the aftermath of the flood, there is a growing general malaise, with people exhausted from assisting family and friends in the clean-up. Across the community, people refer to themselves as suffering from ‘flood fatigue’.

Those not directly impacted by the flood refer to themselves as suffering from ‘hill survivor guilt’ and an inability to relax and live life as normal in the face of the trauma and dislocation experienced by many friends, family members and colleagues.

Children have experienced interruptions to their schooling. Some are dislocated to other towns to stay in emergency accommodation while they wait for cleaning and repair of their homes. Others whose school has been inundated are forced to change schools, are being home schooled with friends or have simply missed weeks of schooling. This not only impacts educational outcomes, but also disrupts friendships and the social development of the children and young people.

So, where could Lismore go?

Lismore could have a strong and prosperous future. However, its future prosperity will be severely limited with repeated adverse economic and social impacts of major flooding events. Lismore's Regional City Action Plan 2036[23] has not suggested change in the location of the CBD or of flood affected areas of housing.

The town's location made sense at the time of its first settlement as a port city on a major transport route. Rivers were essential for water supply and their fertile silted flood plains for food production. Lismore's CBD no long needs to be located alongside the river at the lowest point on the floodplain.

Our vision is of a Lismore with a new heart, a relocated CBD on land above major flood height. One such site is that of the current golf course. The undulating site is above flood height, is close to and well connected to the current CBD by an existing town centre road, Keen Street. The site could also be connected to the existing Wyrallah Road shopping centre which currently has a supermarket and some other speciality retail and food stores. The site is large enough to accommodate most of the current core functions of the CBD. It could, at the very least, be used as a speciality retail precinct for businesses which carry high quantities of stock.

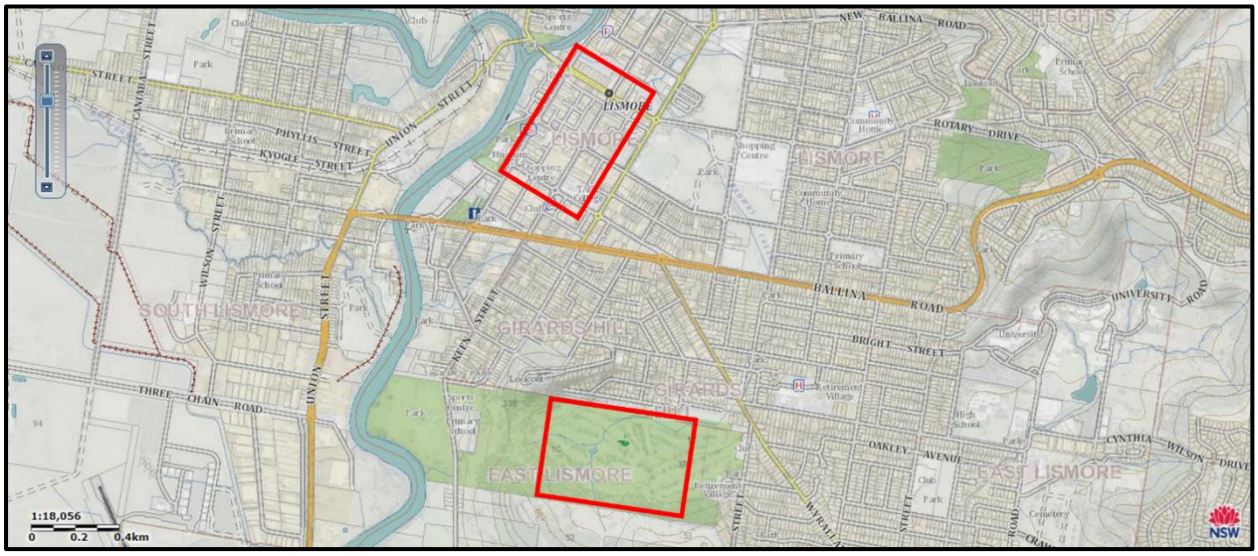

Figure 15. Location of the current CBD in Lismore and of the Lismore golf course, one possible site for redevelopment, at least in part, of the town's CBD (red rectangles are the same size and shape)

Importantly, this site is owned by the NSW State Government, so could be donated for the purpose of 'land swaps' with existing owners of commercial premises in the CBD. With appropriate compensation to cover the cost of building in a new location, owners of commercial premises could be incentivised to relocate to a site above flood height.

This is not to say that all of the CBD needs to move. Lismore has beautiful heritage buildings which could be retained and sympathetically restored, flood proofed and used for administrative, social service and professional activities which are more easily relocated above flood height at times of flooding threat.

[23] https://www.planning.nsw.gov.au/-/media/Files/DPE/Plans-and-policies/Plans-for-your-area/Regional-plans/Lismore-Regional-City-Action-Plan-2036.pdf

These could be retained in the middle of a parkland precinct. Recreational sites such as the heritage cinema and adjoining buildings, the Conservatorium of Music and churches could be retained in the midst of a green space, a cultural and recreational space. The town community could collectively determine uses for this new green riverine town heart. Such uses may include community gardens, sporting venues, an outdoor amphitheatre for concerts and festivals, sculpture gardens, sites for camping or caravanners, among the possibilities. Such an environment is likely to attract travellers and tourists to the town.

Revegetated river banks rather than impervious surfaces would reduce water run-off and act to slow river rise. These could be the site for running and walking tracks, a staged exercise track and provide opportunities for the town population to enjoy the riverine environment more fully. Appropriately flood proofed or easily moved cafes or entertainment businesses may also be appropriate in this environment.

This is one vision to demonstrate what changes could provide a viable and more positive future for Lismore. There may be other appropriate sites to be considered. Exploration will be needed to find appropriate sites for relocation of housing from the most flood prone areas as well, with careful thought given as to how to build a sense of community for those dislocated from their current housing.

Lismore is at a turning point in its history. We advocate careful and thoughtful discussion, based on sound evidence and detailed feasibility studies, rather than on politics or existing vested commercial interests, as a basis for careful planning for a new future for the town, a town which needs a new heart.

Conclusion

As demonstrated in this report, given current data collection sites and methods, it is impossible to accurately predict future flood heights for Lismore. Even if it were, every flood proves different, so to plan mitigation works which will effectively flood proof the current town, its CBD and flood prone housing, is not possible. Thus, based on the realities of the natural environment alone, even without factoring in potential increases in rainfall levels arising from climate change predictions, relocation of core functions of the town and of some housing is the best course of action for the future of Lismore.

Secondly, a cursory analysis of the financial costs of rebuilding the town after repeated flooding events, compared to the cost of relocation of the town now, supports the argument for relocation of much of the CBD and of housing subject to inundation.

Our third point is that, the social, emotional and psychological costs of *not* relocating parts of Lismore which are subject to inundation during flooding are enormous. Relocation of parts of Lismore offers residents and business owners a future which enables them to feel safe to continue their daily life, employment and business activities without risk.

The last major point is that there *are* suitable sites for relocation of parts of Lismore, which are above the 15 metre contour line and therefore above the highest recorded flood height. At least one of these is closely connected to the current CBD, is of a suitable size and consists of land currently owned by the NSW government. Such land could be used to facilitate the change.

One of the basic principles of environmental management is: if you can't remove the risk, move people from the risk. This is apt and applicable in Lismore's case and would provide an exemplar for future relocation of parts of other towns or cities in Australia which repeatedly experience the ravages of environmental disasters.

APPENDIX – Economic Review Summary

Assumptions – Commercial costs

- Core CBD — 20 ha (field assessment)
- Total CBD — 60 ha (field assessment)
- No of businesses -core CBD (known to be low) — 330 (retail census)
- Core CBD Floorspace — 132,802 m2 (estimate from site cover)
- Turnover PA/m2 — $4,500 (typical regional centre figure)
- Stock and equipment losses per business — $70,000 (preliminary estimate)
- Business re-establishment costs — $200,000 (notional figure)
- Waste costs from clear up per tonne — $379 (Council fees and charges)
- Public realm costs — $10M (known to be low)
-

Assumptions – Residential Costs

- No of destroyed buildings — 50
- No of buildings needing major rebuild — 1,000
- No needing significant repairs — 4,000
- Average cost for claim (av damage cost) — $22695 (ICA figures)
- Estimated rebuild cost for dwelling (major damage) — $100,000 (preliminary estimate)
- Estimated replacement cost for modest dwelling — $450,000 (probably low)
- Target new dwellings near new CBD — 880
- Target infill in other urban areas — t.b.a.
- No of significant floods in next 20 years — 5 (extrapolation from current trends)

Assumptions - Land development costs - 2010

- Roads (per ha) — $30,300 (mid rate – outer/inner metro)
- Water and Sewer (per ha) — $14,700 (mid rate – outer/inner metro)
- Telcoms (per ha) — $2,500 (mid rate – outer/inner metro)
- Power — $6,850 (mid rate – outer/inner metro)
- Inflation factor — 1.3
- Av lot costs — $70,655
- Headworks and external works — add 25%

Item	Cost
Preliminary costs to stay - Business	$440M
Preliminary costs to stay - Residential	$398M
Preliminary costs to develop new site	$110M
Preliminary building costs on new site	$440M
Residential avoided costs over 20 years	$2.2B
CBD avoided costs over 20 years	$2.19B